§8. Enhancement of Negative Radial Electric Field by NBI Heating in CHS[1]

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A strong negative E_r near the plasma periphery, which can not be explained by neoclassical theory, has been observed in CHS[2]. We have pointed out that the losses of NBI beam particles play an important role to enhance strong negative E_r in CHS[3]. In the actual plasma anomalous transport would play an important role at the plasma periphery. We study the enhancement of neagtive E_r by NBI beam particles including the effect of an anomalous viscosity.

Figure 1 shows the radial flux due to the beam particles for counter injection NBI heating for two different densities; $n_0 = 2.0$ and $6.0 \times 10^{19}\mathrm{m}^{-3}$. The large radial flux due to beam particle, $\Gamma_i^{fast} \geq 1.0 \times 10^{19} 1/\mathrm{sec}\cdot\mathrm{m}^2$ is observed in both density cases. We assumed a heating power of 1MW.

We, here, introduce the effect of anomalous viscosity and use the ambipolarity condition given by

$$\Gamma_{beam} + \Gamma_i^{NC} - \Gamma_e^{NC} + \frac{1}{V'}\frac{\partial}{\partial\psi}\left(V'D\frac{\partial\Phi'}{\partial\psi}\right) = 0, \quad (1)$$

where we assume $D = D_0 f(r)$ and $f(r) = \{1 + C_1(r/a)^{C_2}\}(C_2+2)/(2+2C_1+C_2)$ with $C_1 = 5$ and $C_2 = 8$, so that the effect of anomalous viscosity becomes large near the plasma periphery. Figure 2 shows the enhancement of E_r in dependence of the NBI heating power in CHS ($n_0 = 6.0 \times 10^{19}\mathrm{m}^{-3}$). In order to estimate the role played by anomalous viscosity we have to compare the strength of the numerically obtained E_r with the experimental one. In the following calculations we fix the value of D_0 in such a way that the strength of the numerically obtained E_r becomes comparable with the experimental one for the case corresponding to a heating power, P = 1MW. We can see that the strength of the negative E_r near the plasma periphery increases with the increasing of the heating power. Additionally the radial width of the region with the strongly enhanced E_r also increases with heating power. The poloidal $E \times B$ Mach number, $M_p = V_{E\times B}B/v_{th}B_p$, is a good measure to evaluate the effect of the obtained E_r on anomalous transport where v_{th} and B_p are the ion thermal velocity and the poloidal magnetic field, respectively. It is found that a heating power of 2MW is required in order to achieve $M_p \sim 2$ for which sudden changes of E_r would be observed.

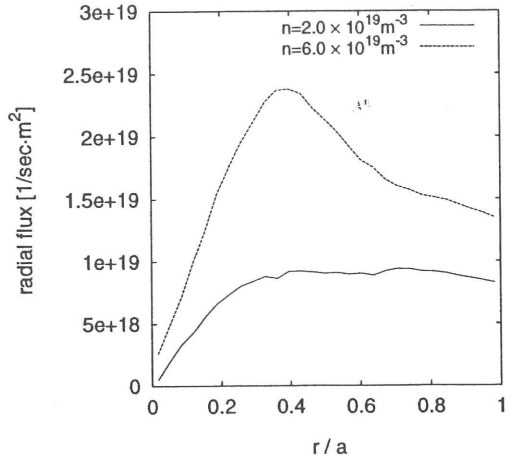

Fig. 1: *Radial flux due to energetic beam particles (counter injection NBI heating, P = 1MW) in CHS for two different densities [n_0 = 2.0 and 6.0 $\times 10^{19}\mathrm{m}^{-3}$].*

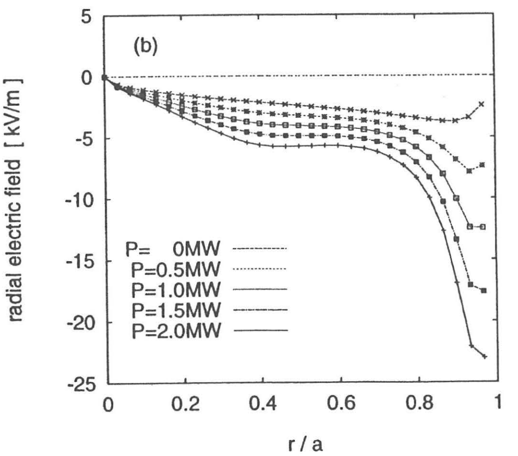

Fig. 2: *Radial electric field enhancement with anomalous viscosity effect with different NBI heating power.*

References

1) Murakami, S., et al., to be published in Plasma Phys. Rep. **23** (1997).
2) K. Ida, et al., Phys. Fluids **B3** (1991) 515.
3) Murakami, S., et al., to be published in Plasma Physics and Controlled Nuclear Fusion Research 1996 (Proc. 16th Int. Conf. Montreal, 1996), IAEA/CP-6.